

# Surface and deep geological constraints as complementary information for the tomographic models of the three target areas of the SECURE Project

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WP1.3 Geological and seismotectonic input data

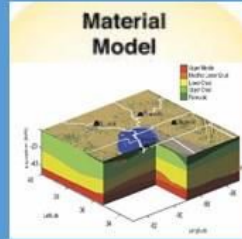


# Project Workflow

## WP1

### Enhancements of Existing Crustal Velocity Models and Seismic Datasets

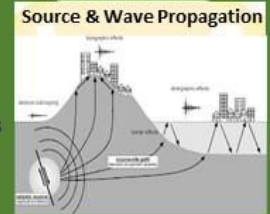
- *Crustal Velocity Models*
- *Strong motion and macroseismic dataset*
- *Geological and seismotectonic input data*



## WP2

### Characterization of Earthquake Source and Seismic Wave Propagation in the Central Apennines

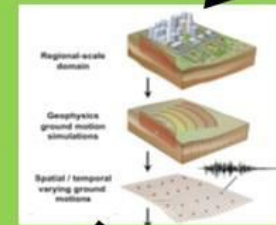
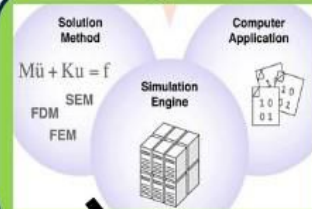
- *Kinematic and Dynamic Earthquake Rupture Modeling*
- *Seismic Wave Attenuation Models*



## WP3

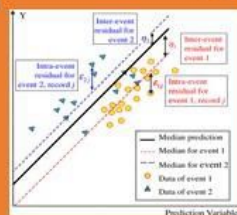
### Ground Motion Predictions using Innovative Approaches

- *Empirical Non-Ergodic Approaches*
- *Physics-based Numerical/Stochastic/Hybrid Ground Motion Simulations*



## WP4

### Testing the Performance of Ground Motion Models and Empirical Relationships



## Dissemination of Results

- *Website*
- *Meetings*
- *Publications*



# Our goals within the SECURE Project:

1. To collect and homogenize available geological data for the three study areas for defining their crustal and shallow geological structures.
2. To prepare a dedicated georeferenced repository of geological, seismotectonic, and seismological information expressly devoted to applications in the SECURE Project.
3. To parameterize all available (i.e. proposed in the literature) seismogenic sources for the three study areas, for exploring the possible influence of their geometrical and kinematic variability on ground motion calculations (***DISS style***).

This WP will furnish input data for the **WP1.1** “Crustal Velocity Models” and **WP2.1** “Kinematic and Dynamic Earthquake Rupture Modeling”.

# Study areas

## Seismotectonic overview

### Area 1

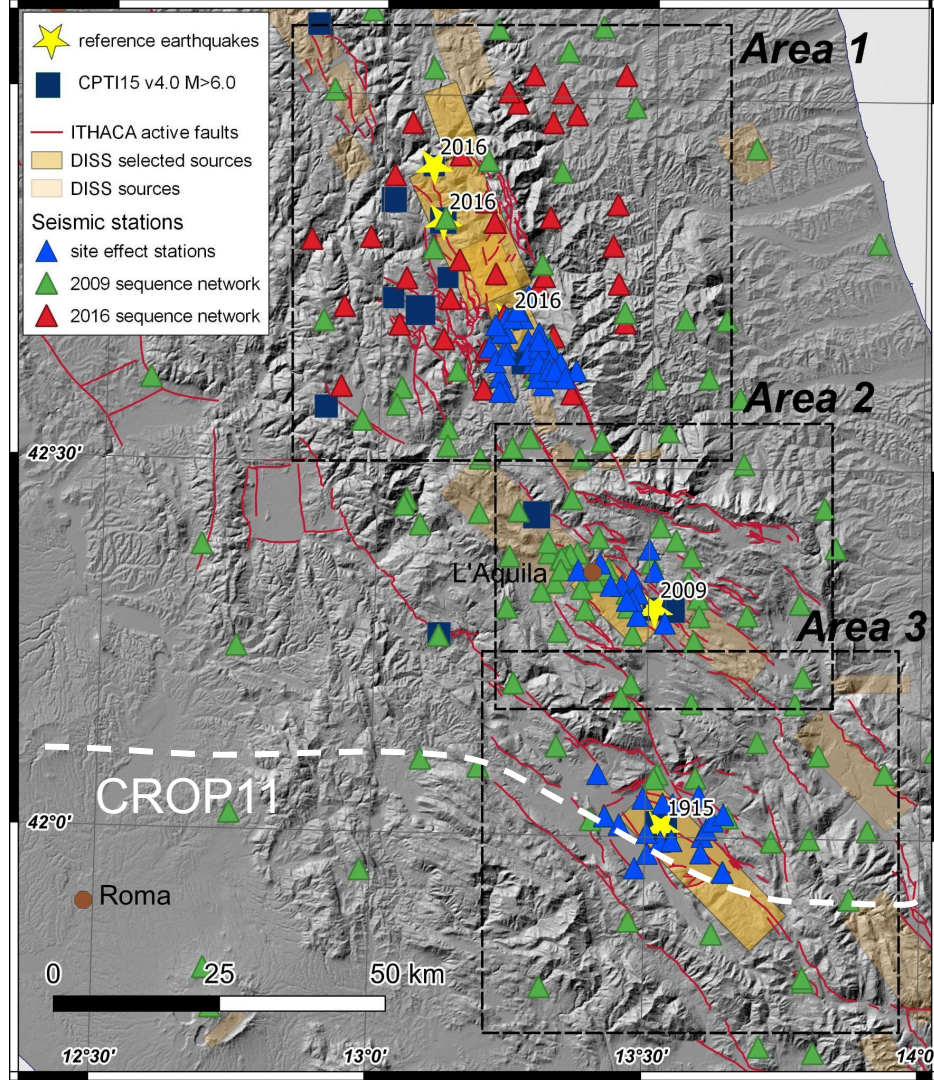
- 2016-2017 AVN seismic sequence
- 1997-1998 Umbria-Marche sequence
- 1703 14 Jan Mw 6.9 Valnerina eq.
- RETRACE-3D Central Italy Geological Model

### Area 2

- 2009 L'Aquila sequence
- 1703 2 Feb Mw 6.7 Aquilano eq.

### Area 3

- 1915 Mw 7.1 Marsica eq.
- Crossed by CROP11 line



# Study areas

Central Apennines paleogeographic and tectonic overview

## Area 1

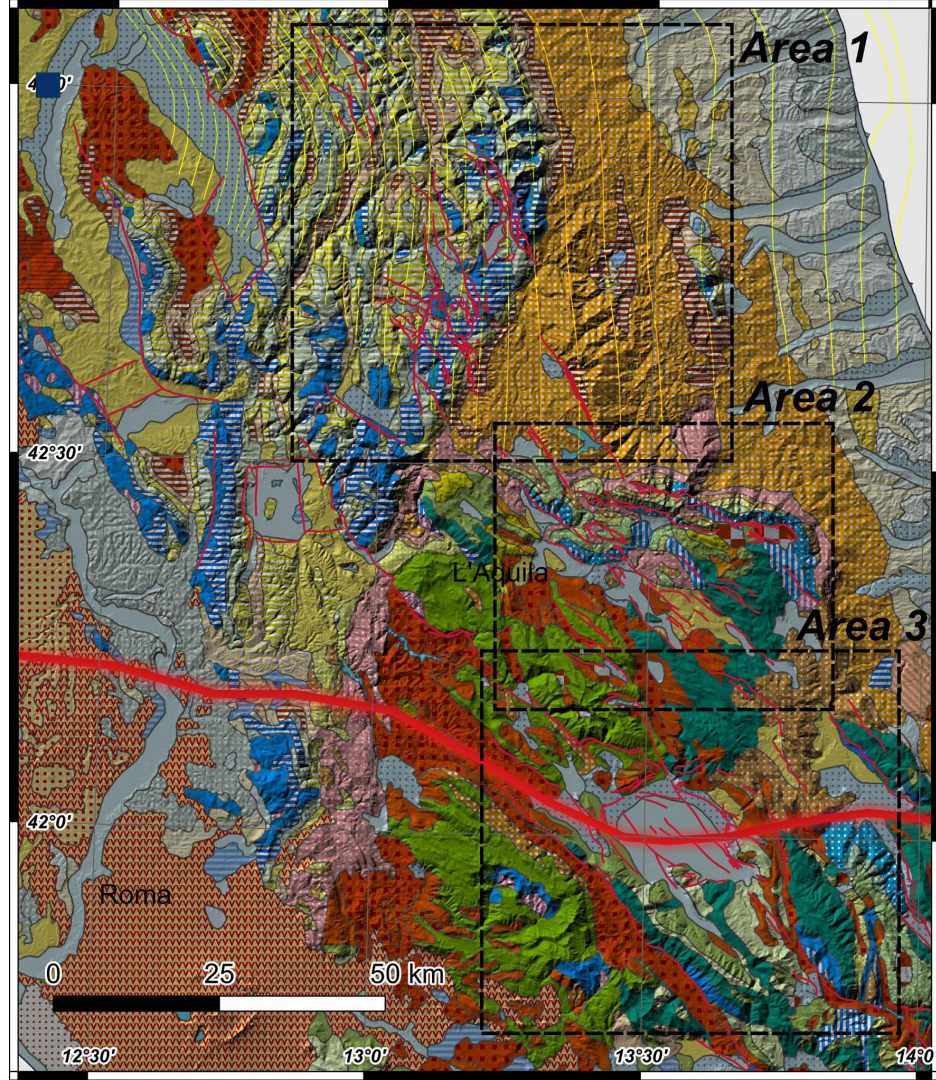
- W-dipping Adriatic monocline
- Sibillini thrust front/Olevano-Antrodoto lateral ramp
- Two W-dipping normal fault systems
- E-dipping low-angle Alto Tiberina Fault
- 5 large intermountain Q basins

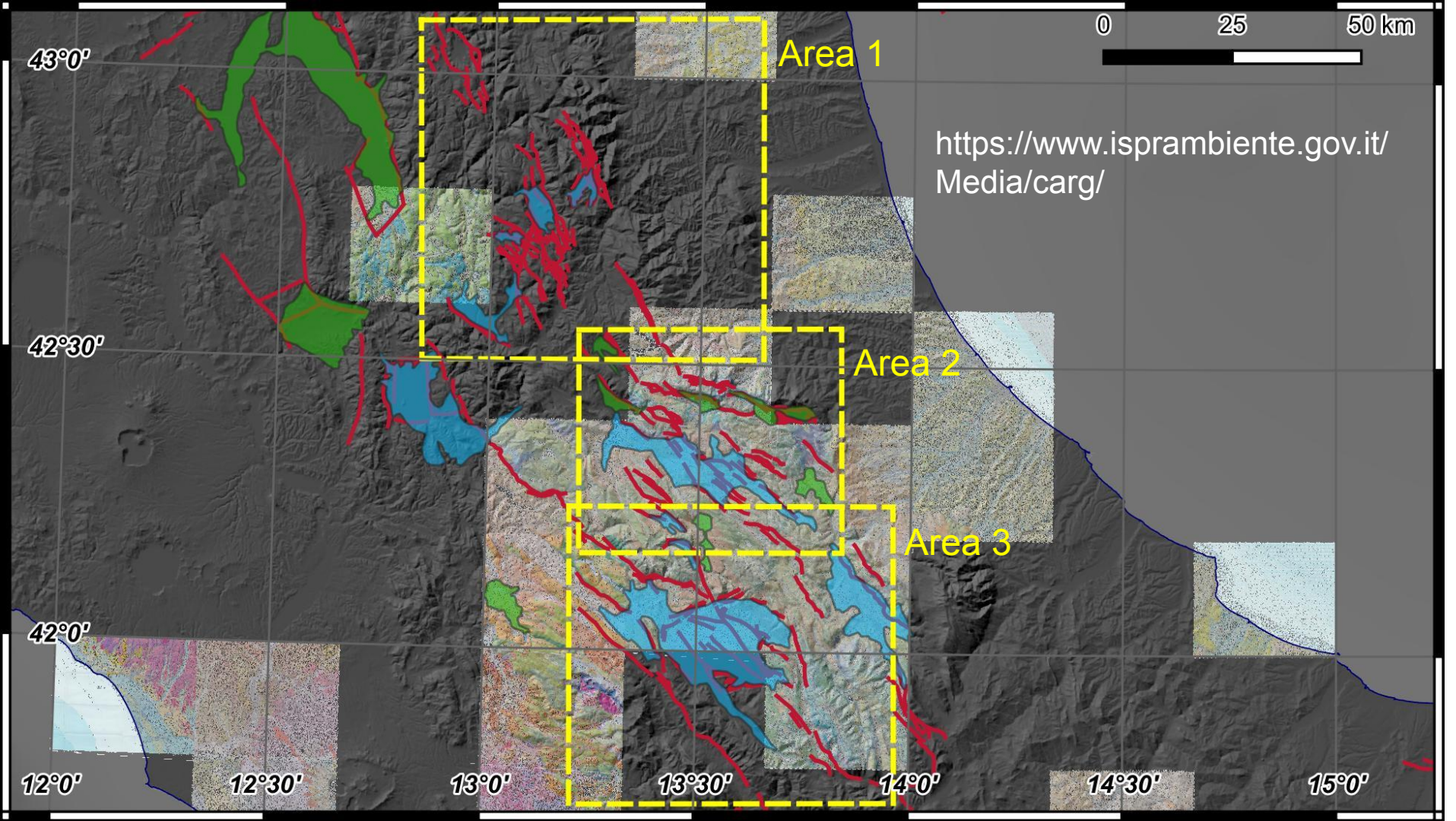
## Area 2

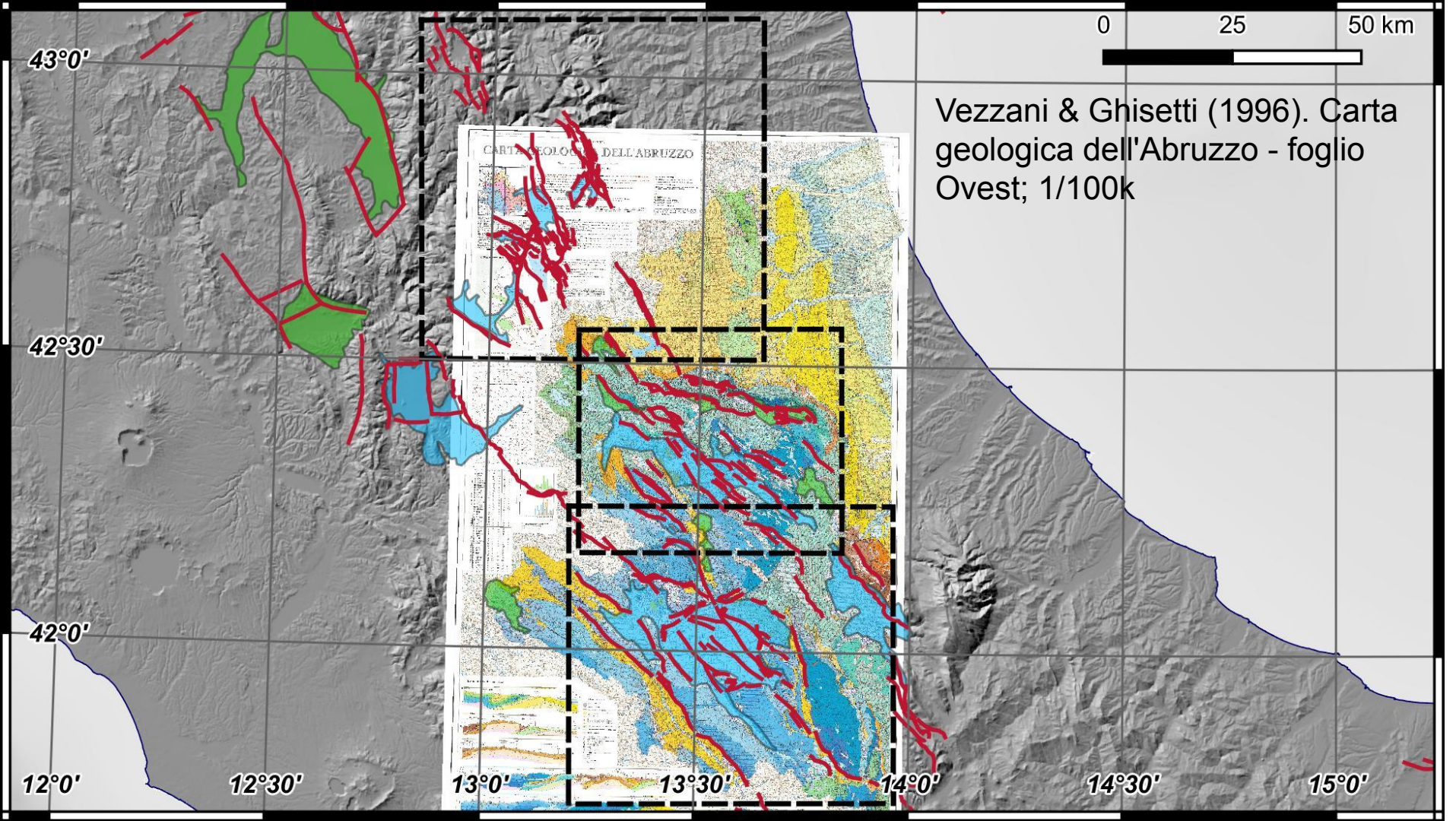
- E-W trending Gran Sasso thrust salient

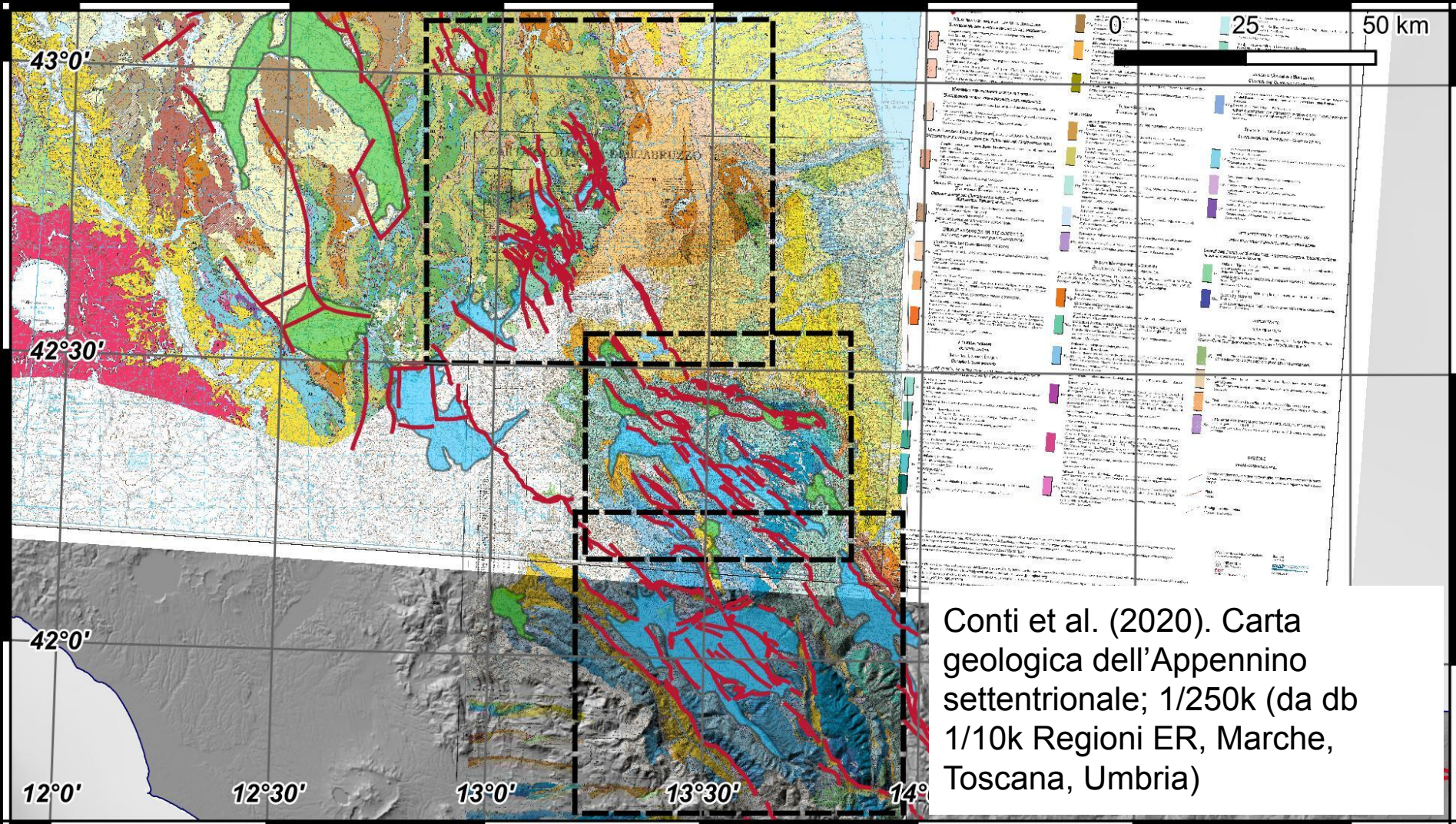
## Area 3

- Fucino largest intermountain basin
- Sulmona Basin

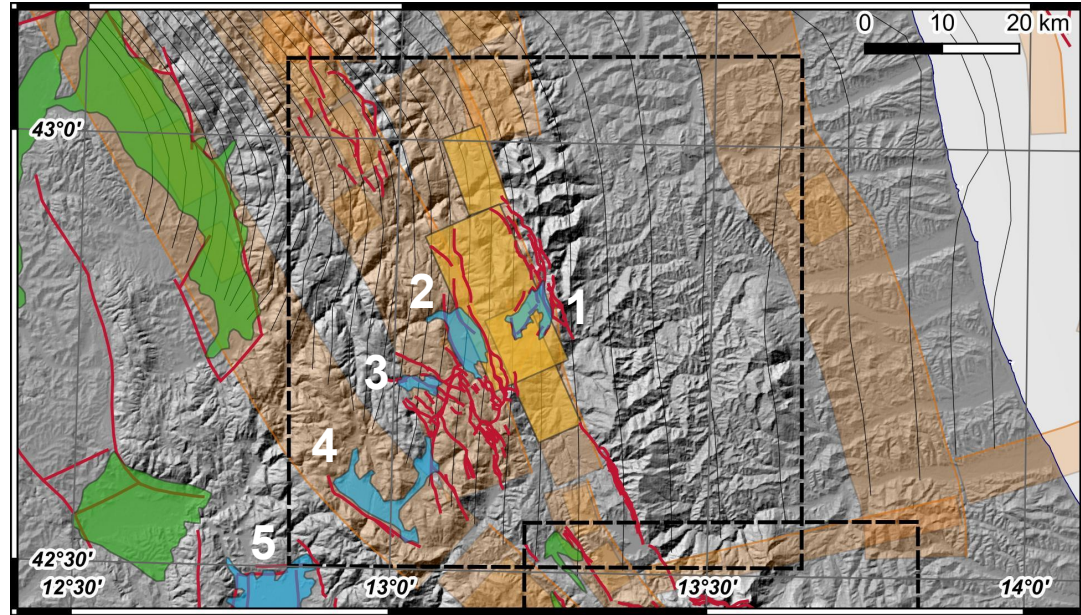
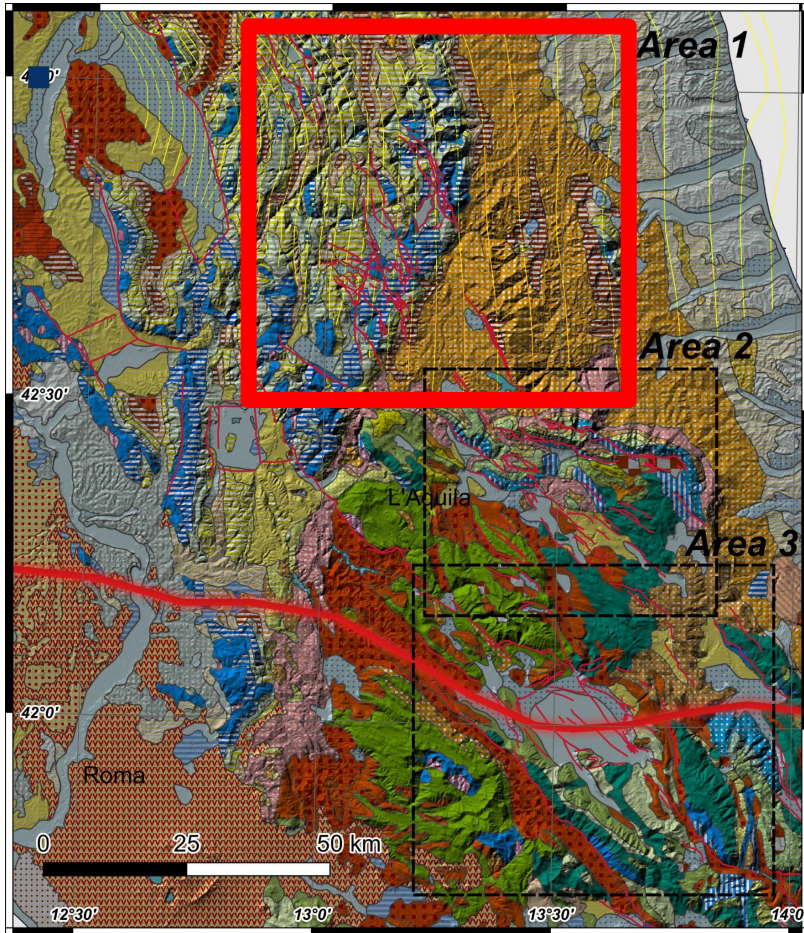






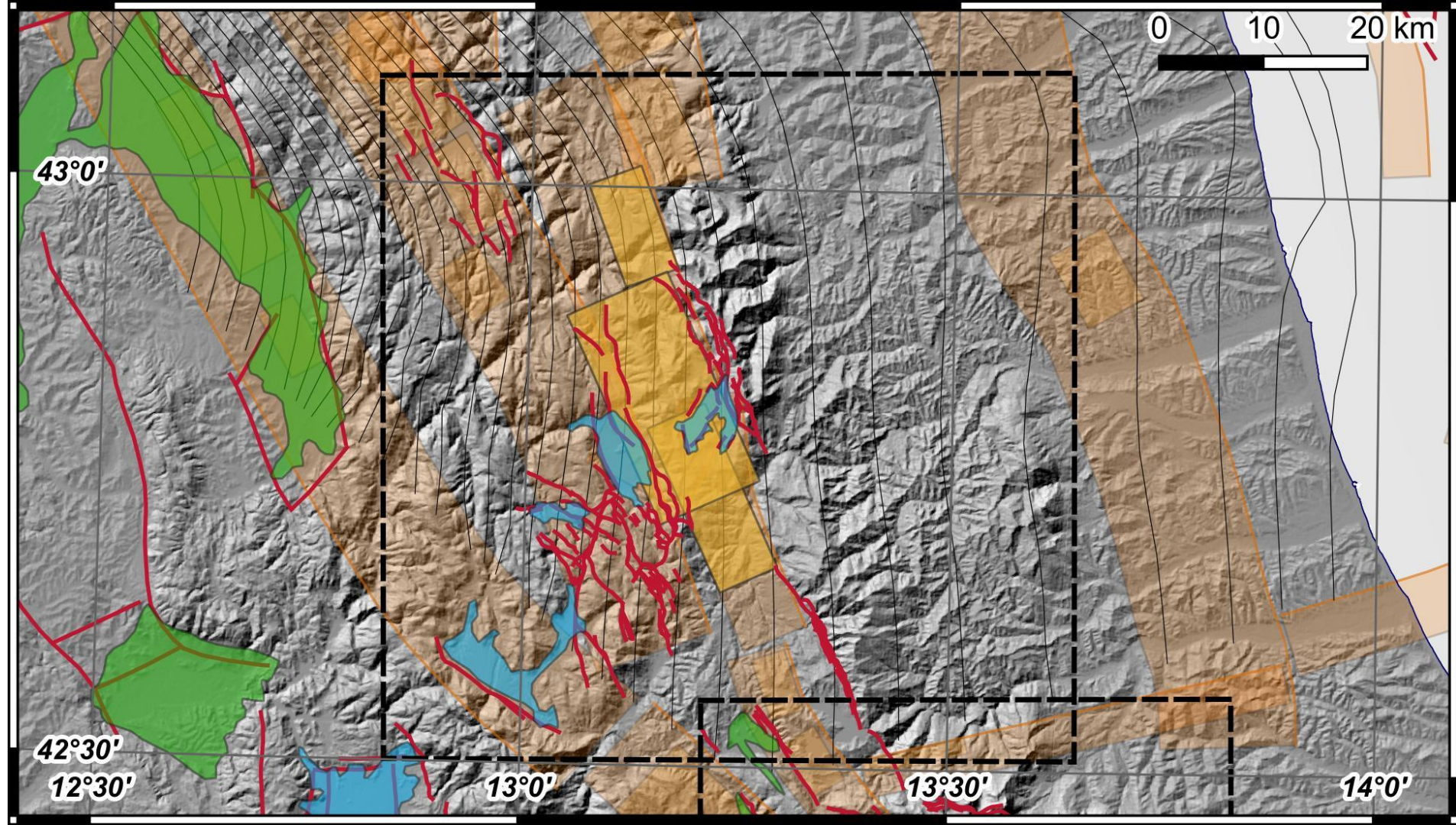


# Study area #1 - Seismotectonic and available data

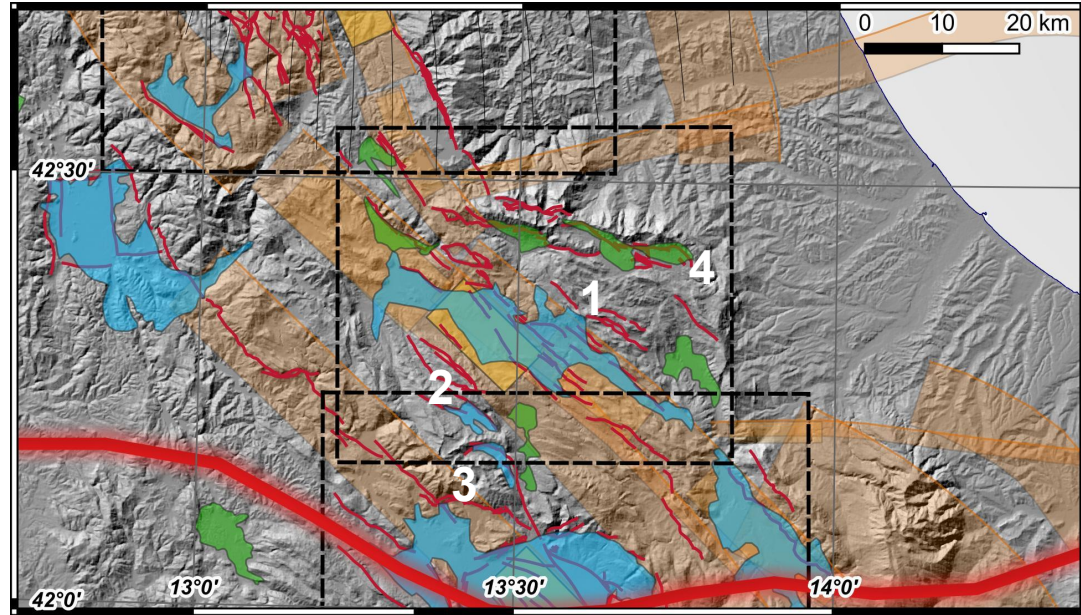
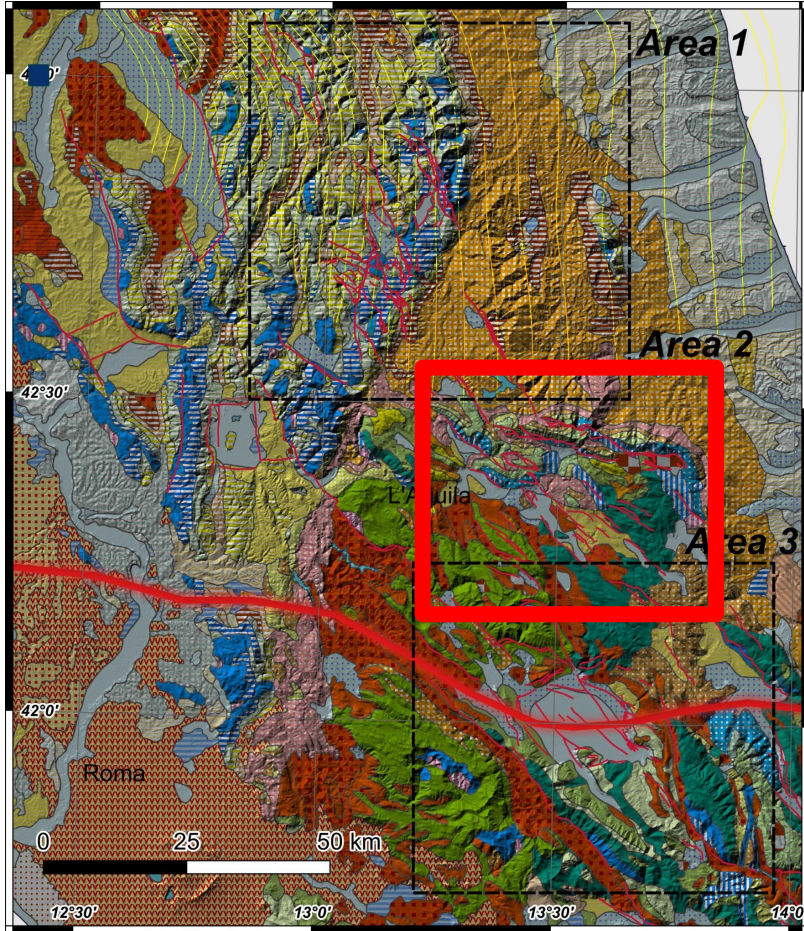


## Quaternary basins with available subsurface studies

- 1- Castelluccio
- 2- Norcia
- 3- Cascia
- 4- Leonessa
- 5- Rieti



# Study area #2 - Seismotectonic and available data



Quaternary basins with available subsurface studies

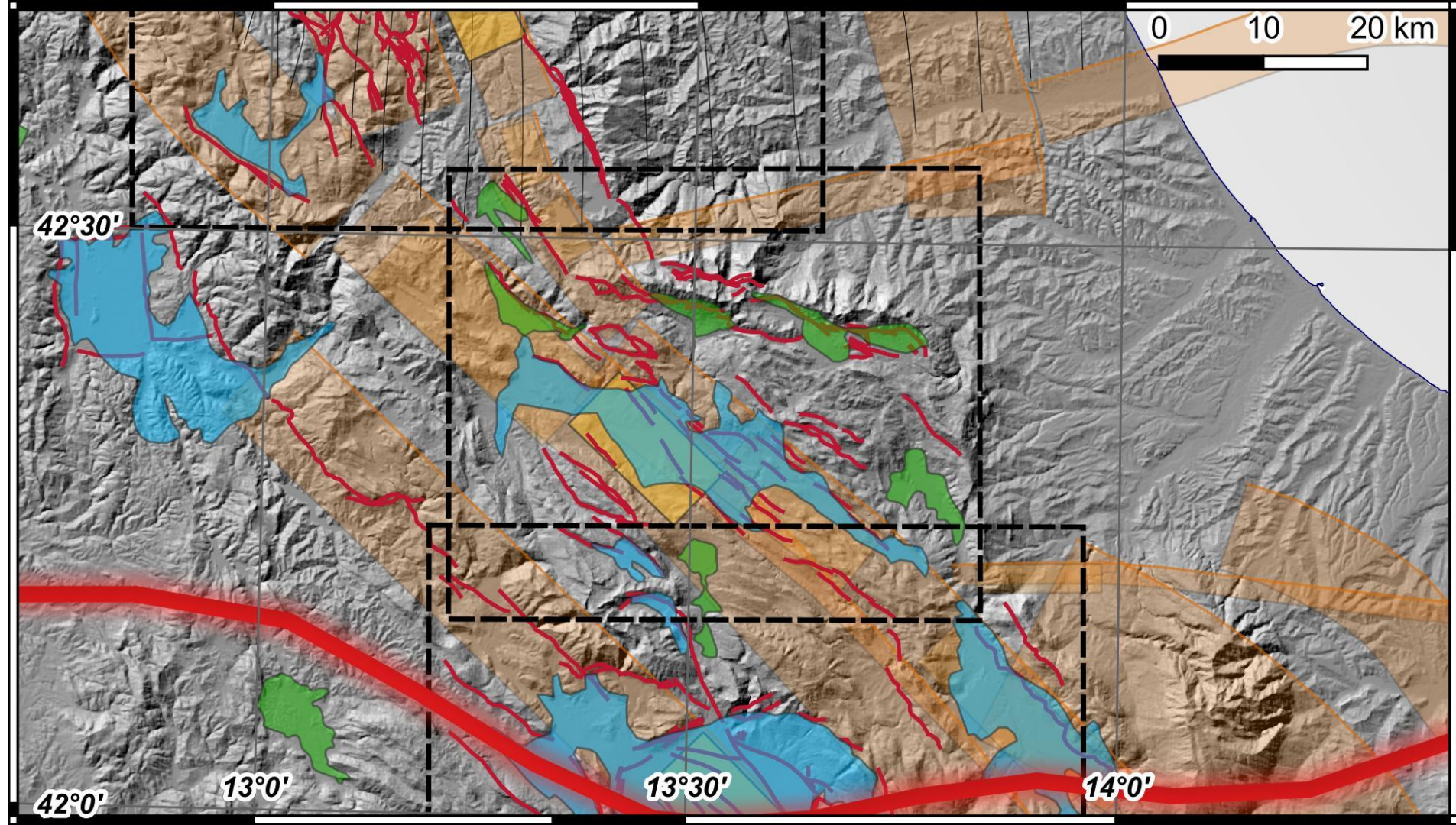
1- Middle Aterno Valley

2- Campo Felice

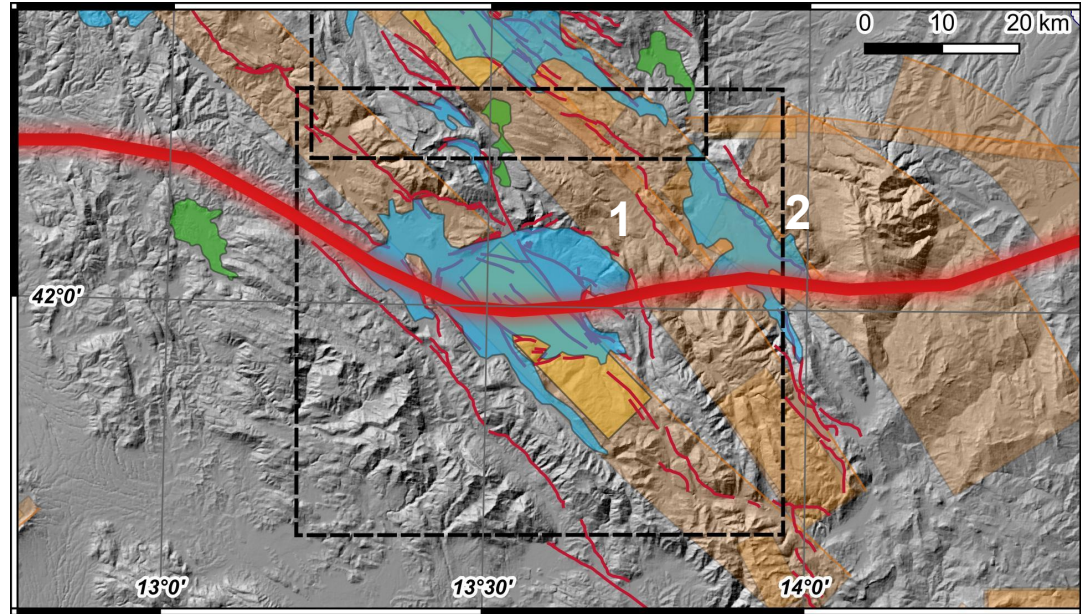
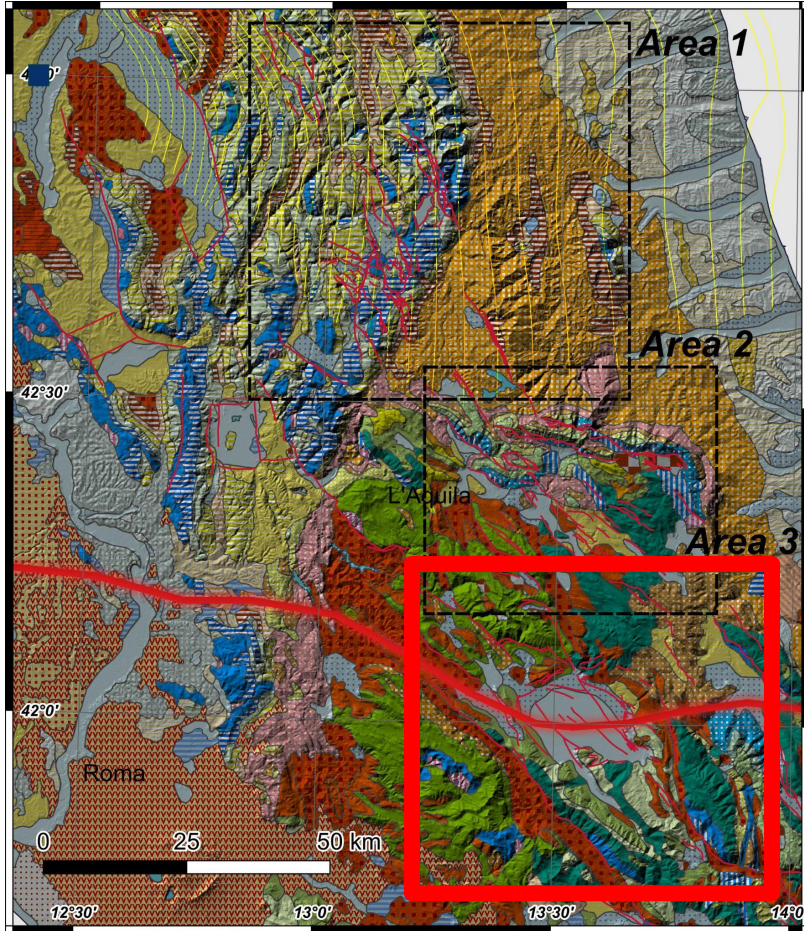
3- Piani di Pezza

Main Quaternary basin w/o subsurface studies

4- Campo Imperatore



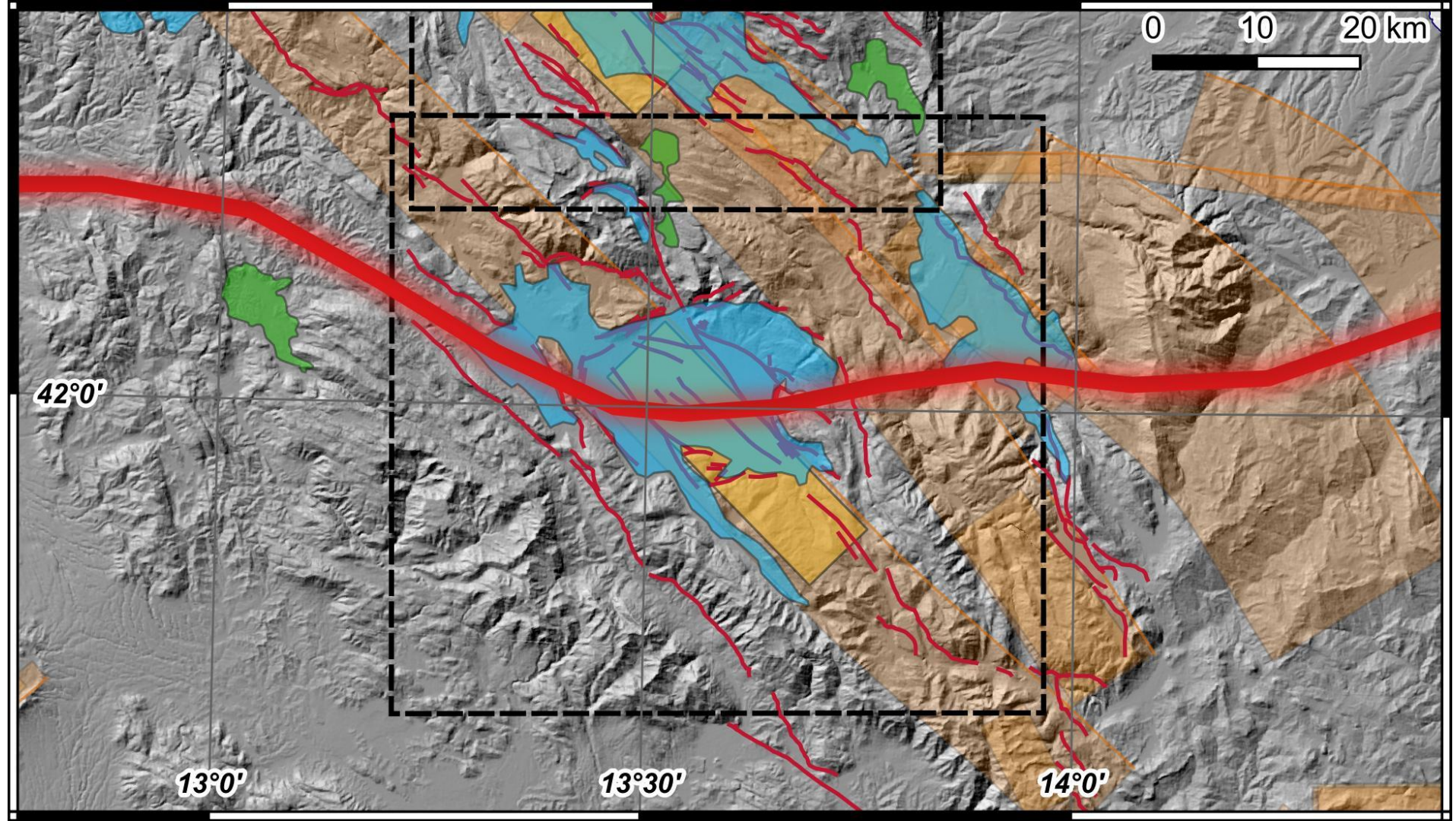
# Study area #3 - Seismotectonic and available data



Quaternary basins with available subsurface studies

1- Fucino Basin

2- Sulmona Basin



# Bibliography - Area #1

Part 1

| Reference                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Technique/Data                              | Sub-Area     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------|
| Buttinelli M., Maesano F. E., Petracchini L., D'Ambrogi C., Scrocca D., Di Bucci D., Basili R., Cara P., Castenetto S., Giuliani R., Salvi I., Bigi S., Cavinato G. P., Di Filippo M., Messina P., Castaldo R., De Novellis V., Pepe S., Solaro G., ... Ventura R. (2021). RETRACE-3D Central Italy Geological Model (Version 1.0) [Data set]. Italian Institute for Environmental Protection and Research (ISPRA). Doi: 10.13127/retrace-3d/geomod.2021. | Various geophysical and geological data     |              |
| Di Giulio et al. (2020). Investigation of the Norcia basin (Central Italy) through ambient vibration measurements and geological surveys. Engineering Geology, 267, doi: 10.1016/j.enggeo.2020.105501.                                                                                                                                                                                                                                                    | Seismic ambient data; surface-wave analysis | Norcia Basin |
| Ferri et al. (2020). Gravity study of the Norcia intermountain basin (central Italy). Bollettino di Geofisica Teorica ed Applicata, 61, doi: 10.4430/bgta0301.                                                                                                                                                                                                                                                                                            | Gravimetry                                  | Norcia Basin |
| Maraio et al. (2023). Active fault detection and characterization by ultrashallow seismic imaging: A case study from the 2016 Mw 6.5 central Italy earthquake. Tectonophysics, 850, doi: 10.1016/j.tecto.2023.229733.                                                                                                                                                                                                                                     | Ultrashallow seismic imaging                | Castelluccio |

# Bibliography - Area #1

## Part 2

| Reference                                                                                                                                                                                                                                                                                                                                        | Technique/Data                            | Sub-Area     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|--------------|
| Pitarka, A., A. Akinci, P. De Gori, M. Buttinelli (2021). Deterministic 3D Ground-Motion Simulations (0–5 Hz) and Surface Topography Effects of the 30 October 2016 Mw 6.5 Norcia, Italy, Earthquake. Bulletin of the Seismological Society of America, doi: <a href="https://doi.org/10.1785/012021013">https://doi.org/10.1785/012021013</a> . | 3D Ground-Motion Simulations              | Norcia Basin |
| Sapia, V., Villani, F., Fischanger, F., Lupi, M., Baccheschi, P., Pantosti, D., et al. (2021). 3-D deep electrical resistivity tomography of the major basin related to the 2016 Mw 6.5 central Italy earthquake fault. Tectonics, 40, doi: 10.1029/2020TC006628.                                                                                | 3D deep electrical resistivity tomography | Castelluccio |
| Skrame, K., M. Di Filippo, M. Di Nezza (2014). A Multidisciplinary Approach for the Determination of Subsurface Structure of Leonessa Plain (Central Apennines, Italy). 20th European Meeting of Environmental and Engineering Geophysics, Athens, Greece, 14-18 September 2014.                                                                 | Gravimetry and microtremor observations   | Leonessa     |

# Bibliography - Area #2

Part 1

| Reference                                                                                                                                                                                                                                                                                                                                           | Technique/Data         | Sub-Area             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------|
| Cesi et al. (2010). Caratteri gravimetrici della media Valle del Fiume Aterno. In Castenetto, S., Naso, G. (Eds). Microzonazione sismica per la ricostruzione dell'area aquilana. Parte I e II. Gruppo di Lavoro "Microzonazione sismica area aquilana". Regione Abruzzo e Presidenza del Consiglio dei Ministri.                                   | Gravimetry             | Middle Aterno Valley |
| Civico et al. (2015). Imaging the three-dimensional architecture of the Middle Aterno basin (2009 L'Aquila earthquake, Central Italy) using ground TDEM and seismic noise surveys: preliminary results. 6th International INQUA Meeting on Paleoseismology, Active Tectonics and Archaeoseismology, 19-24 April 2015, Pescara, Fucino Basin, Italy. | TDEM and seismic noise | Middle Aterno Valley |
| Civico et al. (2017). Geometry and evolution of a fault-controlled Quaternary basin by means of TDEM and single-station ambient vibration surveys: The example of the 2009 L'Aquila earthquake area, central Italy. J. Geophys. Res.: Solid Earth, 122, 3, 2236-2259, 10.1002/2016JB013451.                                                         | TDEM and seismic noise | Middle Aterno Valley |
| Di Nezza, M., Di Filippo, M., and Ferri, F. (2010). Gravity features of the Middle Aterno Valley, 85° Congresso Nazionale della Società Geologica Italiana, Pisa, 6–8 September.                                                                                                                                                                    | Gravimetry             | Middle Aterno Valley |
| Florio et al. (2021). Gravity mapping of basement depth in seismogenic, fault-controlled basins: The case of Middle Aterno Valley (Central Italy). Tectonophysics, 817, doi: 10.1016/j.tecto.2021.229044.                                                                                                                                           | Gravimetry             | Middle Aterno Valley |

# Bibliography - Area #2

## Part 2

| Reference                                                                                                                                                                                                                                                                                                                                       | Technique/Data                                               | Sub-Area             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------|
| Giaccio et al. (2012). Fault and basin depocenter migration over the last 2 Ma in the L'Aquila 2009 earthquake region, central Italian Apennines. Quaternary Science Reviews, 56, doi: 10.1016/j.quascirev.2012.08.016.                                                                                                                         | Morphological, stratigraphical and structural investigations | Middle Aterno Valley |
| Nocentini et al. (2017). Plio-Quaternary geology of L'Aquila – Scoppito Basin (Central Italy). Journal of Maps, 13 (2), 563-574, doi: 10.1080/17445647.2017.1340910.                                                                                                                                                                            | Geology                                                      | Middle Aterno Valley |
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| Pucci, S., R. Civico, F. Villani, T. Ricci, E. Delcher, A. Finizola, V. Sapia, P. M. De Martini, D. Pantosti, S. Barde-Cabusson et al. (2016). Deep electrical resistivity tomography along the tectonically active Middle Aterno Valley (2009 L'Aquila earthquake area, central Italy). Geophys. J. Int., 207, 2, 967-982, 10.1093/gji/ggw308. | Deep electrical resistivity tomography                       | Middle Aterno Valley |

# Bibliography - Area #2

## Part 3

| Reference                                                                                                                                                                                                                                                                                                                                                                                                           | Technique/Data                            | Sub-Area             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------|
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| Tallini, M., M. Spadi, D. Cosentino, M. Nocentini, G. Cavuoto, V. Di Fiore (2019). High-resolution seismic reflection exploration for evaluating the seismic hazard in a Plio-Quaternary intermontane basin (L'Aquila downtown, central Italy). Quaternary International, 532, 10, 34-47, <a href="https://doi.org/10.1016/j.quaint.2019.09.016">https://doi.org/10.1016/j.quaint.2019.09.016</a> .                 | Seismic reflection                        | Middle Aterno Valley |
| Tallini, M., M. Spadi, D. Cosentino, M. Nocentini, L. Macerola, G. Cavuoto, V. Di Fiore (2019). Seismic Hazard of L'Aquila downtown (central Italy): new insights for 3D geological model based on high-resolution seismic reflection profile and borehole stratigraphy.                                                                                                                                            | Seismic reflection and borehole           | Middle Aterno Valley |
| Villani, F., L. Improta, S. Pucci, R. Civico, P. P. G. Bruno, and D. Pantosti (2017). Investigating the architecture of the Paganica Fault (2009 Mw 6.1 earthquake, central Italy) by integrating high-resolution multiscale refraction tomography and detailed geological mapping. Geophys. J. Int., 208, 1, 403-423, 10.1093/gji/ggw407.                                                                          | Geological mapping and HR seismic imaging | Middle Aterno Valley |
| Villani, F., S. Pucci, R. Civico, P. M. De Martini, I. Nicolosi, F. D'Ajello Caracciolo, R. Carluccio, G. Di Giulio, M. Vassallo, A. Smedile et al. (2015). Imaging the structural style of an active normal fault through multidisciplinary geophysical investigation: a case study from the Mw 6.1, 2009 L'Aquila earthquake region (central Italy). Geophys. J. Int., 200, 3, doi:1676-1691, 10.1093/gji/ggu462. | HR seismic reflection and geoelectrical   | Middle Aterno Valley |

# Bibliography - Area #3

## Part 1

| Reference                                                                                                                                                                                                                                                                                                                                                                         | Technique/Data                         | Sub-Area      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|---------------|
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| Caielli, G., R. Maffucci, R. de Franco, S. Bigi, M. Parotto, R. Mollica, I. Gaudiosi, M. Simionato, M. Romanelli, N. De Marchi, G. P. Cavinato (2023). Fucino Basin structure revealed by the tomography and the reusing of the CROP11 seismic data. Tectonophysics, 865, <a href="https://doi.org/10.1016/j.tecto.2023.230043">https://doi.org/10.1016/j.tecto.2023.230043</a> . | Tomography/CROP 11                     | Fucino Basin  |
| Cavinato, G.P., C. Carusi, M. Dall'Asta, E. Miccadei, T. Piacentini (2002). Sedimentary and tectonic evolution of Plio-Pleistocene alluvial and lacustrine deposits of Fucino Basin (Central Italy). Sediment. Geol. 148, 29–59, <a href="https://doi.org/10.1016/S0037-0738(01)00209-3">https://doi.org/10.1016/S0037-0738(01)00209-3</a> .                                      | Seismic reflection                     | Fucino Basin  |
| Di Filippo, M., E. Miccadei (1997). Studio gravimetrico della Conca di Sulmona. Il Quaternario, 10, 2.                                                                                                                                                                                                                                                                            | Gravimetry                             | Sulmona Basin |
| Di Giulio et al. (2016). Seismic response of a deep continental basin including velocity inversion: the Sulmona intramontane basin (Central Apennines, Italy). Geophys. J. Int. (2016) 204, 418–439 doi: 10.1093/gji/ggv444.                                                                                                                                                      | Earthquake ground motion; site effects | Sulmona Basin |
| Giraudi, C. (1988). Evoluzione geologica della piana del Fucino (Abruzzo) negli ultimi 30 000 anni, Il Quaternario, 1, 131-159.                                                                                                                                                                                                                                                   | Geological analysis                    | Fucino Basin  |

# Bibliography - Area #3

## Part 2

| Reference                                                                                                                                                                                                                                                                                                                                       | Technique/Data          | Sub-Area                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------------------|
| Gori et al. (2017). Active faulting, 3-D geological architecture and Plio-Quaternary structural evolution of extensional basins in the central Apennine chain, Italy. Solid Earth, 8, 319-337, doi:10.5194/se-8-319-2017.                                                                                                                       | 3-D geological analysis | Fucino, Subequana and Sulmona valleys |
| Mancinelli et al. (2021). Gravity modeling reveals a Messinian foredeep depocenter beneath the intermontane Fucino Basin (Central Apennines). Tectonophysics, 821, doi: 10.1016/j.tecto.2021.229144.                                                                                                                                            | Gravimetry              | Fucino Basin                          |
| Patacca, E., P. Scandone, E. Di Luzio, G. P. Cavinato and M. Parotto (2008). Structural architecture of the central Apennines: Interpretation of the CROP 11 seismic profile from the Adriatic coast to the orographic divide. Tectonics, 27, TC3006, 10.1029/2005TC001917.                                                                     | CROP 11                 | Fucino Basin                          |
| Villani, F., V. Tulliani, V. Sapia, E. Fierro, R. Civico, D. Pantosti (2015). Shallow subsurface imaging of the Piano di Pezza active normal fault (central Italy) by high-resolution refraction and electrical resistivity tomography coupled with time-domain electromagnetic data. Geophys. J. Int., 203, 1482-1494, doi:10.1093/gji/ggv399. | HR refraction and ERT   | Piano di Pezza                        |



*GRAZIE PER L'ATTENZIONE!*